A Stochastic Skeleton Model for the MJO

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Abstract

The Madden-Julian oscillation (MJO) is the dominant mode of variability in the tropical atmosphere on intraseasonal timescales and planetary spatial scales. The skeleton model is a minimal dynamical model that recovers robustly the most fundamental features of the MJO such as its propagation speed, peculiar dispersion relation, quadrupole vortex structure, etc. This model depicts the MJO as a neutrally-stable atmospheric wave that involves a simple multiscale interaction between planetary dry dynamics, planetary lower-tropospheric moisture and the planetary envelope of synoptic-scale convective activity.

We will show that the skeleton model can reproduce the intermittent generation of MJO events and their organization into wave trains with growth and demise with stochastic fidelity with the observational record. We achieve this goal by developing a simple stochastic parametrization for the unresolved details of synoptic-scale convective activity, that is coupled to otherwise deterministic processes in the skeleton model. In

particular, the intermittent initiation, propagation and shut down of MJO wave trains in the skeleton model occur through these stochastic effects. In addition to this, we will discuss how the skeleton model may qualitatively reproduce additional features of intraseasonal variability when it accounts for more details of the meridional and vertical structure of convective activity. This includes MJO events with realistic front-to-rear (i.e. tilted) vertical structure as well as intraseasonal events with off-equatorial heating or northward propagation as in the asian monsoon.